

A New Species of *Acanthurus* from the Caroline Islands, with Notes on the Systematics of Other Indo-Pacific Surgeonfishes¹

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SINCE THE PUBLICATION of several articles on the systematics of surgeonfishes by the author (see References), specimens of an undescribed species of *Acanthurus* from the Caroline Islands have been obtained as well as information of value for various other acanthurids. The opportunity to acquire most of these data was provided by a fellowship from Yale University and the Bernice P. Bishop Museum for ichthyological research in French Oceania. The specimens of the new *Acanthurus* were loaned by Robert R. Rofen of the George Vanderbilt Foundation, Stanford University. For methods of counting and measuring see Randall (1956b: 165).

Acanthurus chronixis, n. sp.

Fig. 1

HOLOTYPE: Stanford Natural History Museum No. 52104; Teawataman Ship Pass, south side of Kapingamarangi Atoll, Caroline Islands (1° 02' 09" N., 154° 45' 04" E.), 1 mi. from shore at a depth not greater than 20 ft. over a coral, sand bottom; spear; R. Rofen and Kapingan fishermen; July 13, 1954. One female specimen, 211 mm. in standard length and 278 mm. in total length.

DESCRIPTION: Dorsal rays VIII, 26; anal rays III, 24; pectoral rays 17 (uppermost a short bony splint); pelvic rays I, 5; principal caudal rays 16; scale rows from gill opening to end of caudal spine approximately 150 (not in even rows and difficult to count); anterior gill rakers 22; posterior gill rakers 27; upper teeth 22, with 7 or 8 denticulations; lower teeth 22, with 6 or 7 denticulations.

Depth of body 2.05, head length 3.46, snout length, 4.58, length of pectoral fin 3.51, length of pelvic fin 4.69, snout to origin of dorsal fin

2.28, snout to anus 2.34, length of dorsal fin base 1.54, length of anal fin base 2.11—all in standard length. Greatest diameter of eye 4.30, width of body 2.18, width of interorbital space 3.08, postorbital length of head 5.92, least depth of caudal peduncle 2.56, length of caudal peduncle 3.06, length of caudal peduncle spine 4.06, anus to origin of anal fin 5.08, length of pelvic spine 2.04, length of first dorsal spine 4.92, length of second dorsal spine 2.76, length of third dorsal spine 2.44, length of eighth dorsal spine 1.92, length of first dorsal ray 1.75, length of first anal spine 16.5, length of second anal spine 3.18, length of third anal spine 2.30, length of first anal ray 2.00, caudal concavity 1.9, width of mouth 4.26—all in head length. Length of longest upper tooth 3.1 mm.; length of longest lower tooth 2.8 mm. Snout produced. Stomach large, round, and thick-walled.

Color in alcohol dark brown; an indistinct darker brown spot anterior and adjacent to upper end of gill opening, and a second spot, elliptical in shape and more distinct, posterior to upper end of gill opening; opercular membrane darker brown than rest of body; a very dark brown band at extreme base of dorsal fin. Life colors unknown.

POSSIBLE JUVENILES: Two small surgeonfish, one juvenile, 46.9 mm. in standard length and 61.2 mm. in total length, and one postacronurus, 34.5 mm. in standard length and 45.4 mm. in total length, were collected from the reef flat west of the northern end of Falarik Islet, Ifaluk Atoll, Caroline Islands (7° 15' 33" N., 144° 26' 10" E.), about .4 mi. from shore at a depth of 6 ft. over a bottom of coral, encrusting algae, and sand with the use of rotenone by Ifaluk fishermen for R. Rofen on October 30, 1953. Figure 2 is a photograph of the two specimens. The juvenile has a produced snout, and both specimens possess eight dorsal spines. Only three known species of *Acanthurus* have eight dorsal

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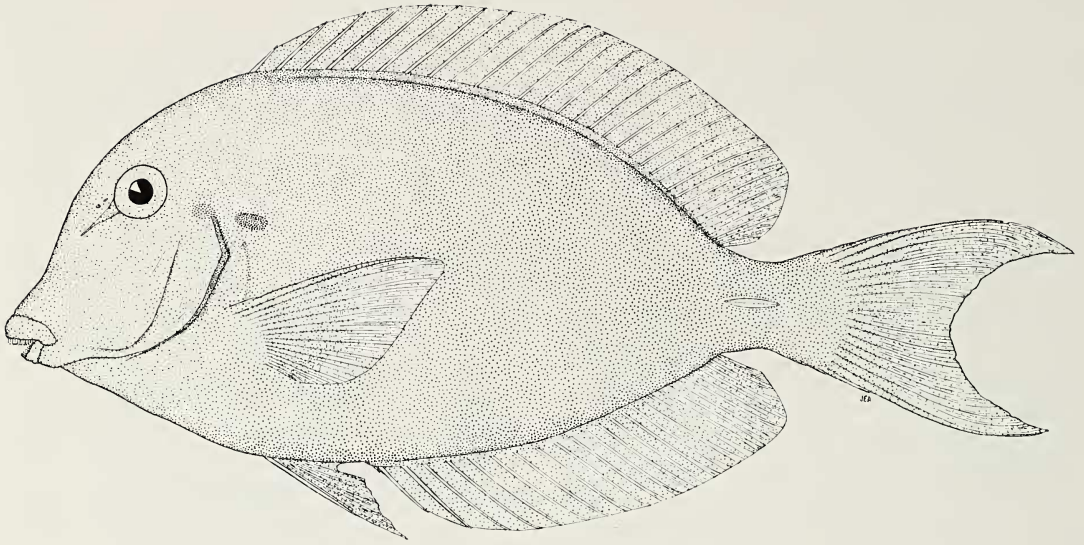


FIG. 1. Holotype of *Acanthurus chronixis* from Kapingamarangi, Caroline Islands; standard length 211 mm.

spines, *A. sobal* (Forskål), *A. pyroferus* Kittlitz, and *A. chronixis*. The young of *sobal* is known (Randall, 1956b: fig. 1), and the young of *pyroferus* is described later in this paper. Although a series of specimens is lacking to link the two small ones from Ifaluk to the holotype, it seems likely that they represent the young of *A. chronixis*. There are meristic differences, however, that arouse some suspicion. The two small specimens have 15 pectoral rays and 27 or 28 soft dorsal rays, as opposed to 17 pectoral rays and 26 soft dorsal rays for the holotype. The possibility that these two specimens are the young of a species as yet undescribed cannot be discounted. For this reason they are not designated as paratypes of *chronixis*. They are deposited in the Stanford Natural History Museum (SNHM) under the number 52105. Their description follows (data for the transforming specimen in parentheses).

Dorsal rays VIII, 27 (28); anal rays III, 25 (25); pectoral rays, 15 (15); upper teeth, 12 (16, the two medial ones large and like adult teeth); lower teeth, 12 (18, a single large medial one).

Depth of body 1.78 (1.64), head length 3.21 (2.98), snout length 4.74 (5.95), length of pectoral fin 2.59 (2.63), length of pelvic fin

3.72 (4.10), snout to origin of dorsal fin 2.06 (2.33), snout to anus 2.18 (2.01), length of dorsal fin base 1.40 (1.41), length of anal fin base 1.95 (1.89)—all in standard length. Greatest diameter of eye 2.44 (2.70), width of body 2.00 (2.19), width of interorbital space 2.86 (3.14), postorbital length of head 3.74 (4.46), least depth of caudal peduncle 2.70 (2.76), length of caudal peduncle 4.30 (4.92), length of caudal peduncle spine 6.95 (7.26), length of pelvic spine 1.85 (2.70), length of first dorsal spine 5.40 (4.83), length of second dorsal spine 2.61 (2.32), length of third dorsal spine 1.87 (2.15), length of eighth dorsal spine 1.23 (1.84), length of first dorsal ray 1.20 (1.76), length of first anal spine 5.21 (5.80), length of second anal spine 2.66 (2.83), length of third anal spine 1.72 (2.07), length of first anal ray 1.46 (1.90), width of mouth 3.56 (3.87)—all in head length. Caudal fin markedly rounded.

Color in alcohol of juvenile light brown with numerous faint pale spots on body, some confluent dorsally to form short vertical or diagonal pale bars; median fins with dusky membranes, the dorsal and anal with rows of pale spots and the caudal with a narrow pale margin and a faint spotting in middle portion of fin; edge of upper portion of opercle dusky. Color of postacronurus uniform light tan with a ver-

tical dusky band at base of caudal fin. Life colors unknown.

DISCUSSION: The transformation of the acronurus larval form into the juvenile stage involves some striking morphological changes. Notable are the formation of scales from narrow vertical ridges on the body and a prolongation of the snout. The difference in relative length of the snout of the two small specimens should be kept in mind when comparing proportional measurements involving head length.

A. chronixis is closely related to *A. pyroferus*, having a similar configuration, especially with respect to the produced snout, similar meristic data, and the same stomach structure. The young of both species appear to be the only ones of the genus with rounded caudal fins, and both develop strongly lunate fins as adults. *A. chronixis* differs from *pyroferus* principally in coloration; it lacks the broad pale terminal band of the caudal fin, the white line nearly encircling the mouth, and the large pale area on the pectoral fin. Also there are different markings on the shoulder region of the two species. The type locality of both species is the Caroline Islands.

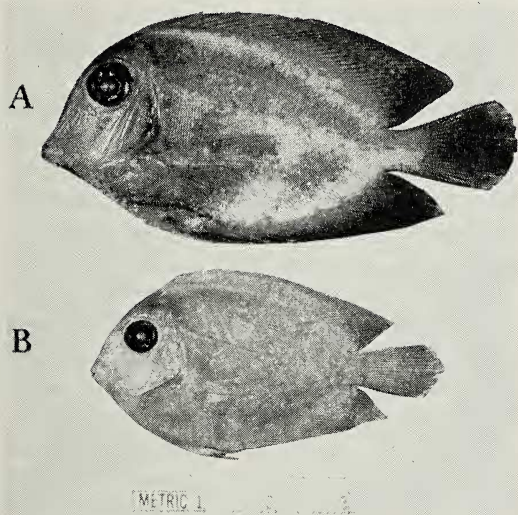


FIG. 2. A, Juvenile of *Acanthurus chronixis*; standard length 46.9 mm. B, Postacronurus of *A. chronixis*; standard length 34.5 mm. Both specimens from Ifaluk, Caroline Islands. Photo by W. Courtenay.



FIG. 3. Juvenile of *Acanthurus pyroferus* Kittlitz from the Society Islands; standard length 43 mm. Reproduced from a 35 mm. Kodachrome transparency. Color in life bright yellow with blue markings on head.

NOTES ON OTHER SPECIES

Randall (1956b: 197) cast some doubt on the statement of Kittlitz (1834) that the young of *Acanthurus pyroferus* are dirty yellow in color, by suggesting that this author might have confused the young of this species with *A. olivaceus* Bloch and Schneider. Recent collections of *A. pyroferus* in the Society Islands (Fig. 3 represents the smallest specimen taken) have revealed that Kittlitz was largely correct. The young are yellow in color, although bright yellow. Kittlitz, of course, may have seen specimen(s) transforming from juvenile to the dark brown adult coloration, at which time the principal color might be described as dirty yellow. The change-over in color in three specimens occurred at standard lengths of 88, 94, and 95 mm. One from the Marquesas had nearly attained adult color patterns at a standard length of 98 mm.

In addition to the bright yellow color, juveniles of *A. pyroferus* have a brilliant blue ring around the eye, a blue margin on the opercle, a blue ring nearly encircling the mouth, a small bright orange area just above the base of pectoral fin, and a narrow pale margin and thin, black submarginal line posteriorly on the median fins. This striking color pattern is precisely the same as that of the small angelfish *Centropyge flavis-*

simus (Cuvier and Valenciennes), thus suggesting the phenomenon of mimicry. Also both *C. flavissimus* and the young of *A. pyroferus* have rounded caudal fins. If mimicry is involved, then the surgeonfish would seem to be the mimic and the angelfish the model, for the former is less common, and it loses the color and caudal-fin shape of *C. flavissimus* when it grows to a size greater than attained by the angelfish. Attempts to deduce the basis for the alleged mimicry were not successful. The problem will be discussed in greater detail in a forthcoming paper on mimicry.

Adults of *A. pyroferus* have very lunate caudal fins. The transformation in shape of the caudal fin of this species begins before adult color pattern is assumed. A 70 mm. specimen, still bright yellow, has a caudal fin less rounded than smaller specimens. The lobes of the caudal fin of a 92 mm. yellow specimen and a 95 mm. brownish-yellow specimen are just starting to form.

The counts of the soft rays of the dorsal and anal fins of *A. pyroferus* from the Society Islands are higher than the counts from specimens in the Marshall Islands and Philippines (Table 1), indicating that the population in the former island group may be distinct from the latter two, which in turn, appear differentiated. A more detailed analysis must await the collection of additional specimens from these and intermediate island areas of the tropical Pacific.

Specimens of *A. pyroferus* from the Society Islands have been sent to the U. S. National Museum (USNM) and the SNHM.

The possible hybrid surgeonfish *Acanthurus achilles* \times *Acanthurus glaucopareius* (Randall, 1956a: 21-25) is known from three specimens, originally described as *A. rackliffei* by Schultz (1943: 157, 163, fig. 13) from Hull Atoll,

Phoenix Islands, in the central Pacific. The hypothesis that these specimens are hybrids would be strengthened if specimens were obtained in other areas where both *A. achilles* Shaw and *A. glaucopareius* Cuvier are known to occur.

In February, 1956, at Caroline Atoll (10° S., 150° 14' W.), a single adult of the postulated hybrid was sighted in the clear water off the lee reef. It was wounded with a spear but not captured. It was intermediate in life color to the parent species (no information on life color was available for the original three specimens of *rackliffei*). In subsequent months, three specimens were speared in the Tuamotu Archipelago. One, 110 mm., was obtained from Makatea directly off the phosphate loading area. It was the only hybrid seen at this island. Three were observed at the atoll of Takaroa; one of these, a 140 mm. specimen, was taken in the lagoon near the pass. The third specimen, 132 mm. in standard length, was collected from the outer reef at Takapoto. A single hybrid was seen in the pass at Tikahau but was not taken. At all of the islands where the hybrids were sighted, *A. achilles* and *A. glaucopareius* were very abundant, hundreds of both species being seen in each area.

One of the Takaroa hybrids was consistently seen at the entrance to the pass. It was a large adult with a scar on the back, thus permitting positive identification during the week that it was observed. This fish was constantly harassed by individuals of *A. glaucopareius*, the latter being perhaps the most pugnacious species of the genus. At times the hybrid experienced almost no respite, for it would flee from one aggressor only to meet with another nearby.

The dorsal and anal fin-ray counts of the new specimens (Makatea and Takapoto, D IX, 30; A III, 27; Takaroa D IX, 29; A III, 27) and their color and morphology are the same as that of the Hull Island hybrids. The life colors of the Takaroa specimen are as follows: body purplish black; a small orangish-yellow region surrounding and extending anterior to spine on caudal peduncle (reaches 7 mm. in front of spine and is a maximum of 4 mm. in height); a very faint pale area under eye; a purplish-white ring encircling lower half of mouth;

TABLE 1
FIN-RAY COUNTS OF SPECIMENS OF
Acanthurus pyroferus FROM THE PACIFIC OCEAN

LOCALITY	DORSAL SOFT RAYS				ANAL SOFT RAYS				
	27	28	29	30	24	25	26	27	28
Society Is.		4	8	5		2	8	6	1
Marshall Is.	2	2				2	2		
Philippine Is.	5				1	4			

dorsal and anal fins colored like body except for narrow, pale blue margins and an orangish-yellow area at the base of these fins which is broader posteriorly; caudal fin colored like body basally, pale distally, these two regions separated by a broad area which appears salmon underwater, and is the best recognition mark of the hybrid (examined closely this colored area is reddish orange outwardly and orangish yellow inwardly, with lobes of orange extending into the yellow).

The Makatea and Takapoto specimens have been deposited in the SNHM (48869), and the Takaroa hybrid at the USNM (169883) (two of the original hybrids are located at the USNM and the third at the Museum of Comparative Zoology at Harvard).

Two specimens of *Acanthurus nubilus* (Fowler and Bean), previously known only from Celebes in the East Indies, were collected by spearing in Moorea, Society Islands, outside the barrier reef. This species seemed moderately common in this area at depths of about 70–130 ft. Like *A. thompsoni* (Fowler), with which it was occasionally associated, it was frequently observed well off the bottom.

When seen underwater, *nubilus* was predominantly light blue except for a white caudal fin and a region of yellow around the caudal spine. After spearing and removing the fish from the water, it was noted that the white tail had altered to dark gray, and the body was dark yellowish brown with numerous lengthwise blue lines (60 counted vertically from origin of anal fin on 158 mm. specimen, and 66 on 169 mm. specimen). The blue lines were about half the width of intermediate brown bands. The head and thorax were bright blue with numerous, close-set, round, dark yellowish-brown spots (in diameter about one-third the diameter of pupil of eye). A broad, brownish-yellow area was visible around the caudal spine; the socket of the caudal spine was whitish, the sheath whitish medially, shading through yellow to black at edge. The dorsal and anal fins were bluish gray basally and greenish brown distally with numerous dark brown bands. The pectorals were hyaline with blackish rays and the pelvics pale blue with blackish rays.

The following counts and proportional measurements were made on the specimens: D VII, 27; A III, 23 and 24; P 16; anterior and posterior gill rakers 23 (one specimen only); caudal concavity 6.7, head length 4.5, depth 2 to 2.1—all in standard length; longest dorsal ray equal to head length; eye 3 in head length.

These two fish differ from the 153 mm. holotype in the USNM in less body depth (1.8 in holotype) and shorter head (head length of holotype 4.1). In view of the great similarity in other features such as color pattern, I regard the above differences in measurement as probably within the range of variability of the species. The specimens have been deposited in the SNHM.

The acanthurids from collections of fishes made at islands in the Indian Ocean in 1957 by James E. Morrow and associates were loaned to the author from the Bingham Oceanographic Laboratory, Yale University. The following species were collected in the Maldives: *Acanthurus triostegus* (Linnaeus), *A. lineatus* (Linnaeus), *A. gabbii* (Forskål), *A. leucosternon* Bennett, *A. nigrofuscus* (Forskål), *Ctenochaetus striatus* (Quoy and Gaimard), and *Zebrasoma veliferum* (Bloch). From the Seychelles the following were taken: *Acanthurus triostegus*, *A. lineatus*, *A. leucosternon*, *A. nigrofuscus*, and *A. tennenti* Günther. The collections were made with rotenone from inshore waters.

Acanthurus leucosternon is as well represented in the collections as other surgeonfishes, which stands in opposition to the statement of Randall (1956b: 196) that the species does not appear to be common, a view based on the paucity of specimens in the United States. The new specimens are most welcome in providing material for additional fin ray counts (Table 2).

A. leucosternon appears to be confined to the Indian Ocean and East Indies. The closely related *A. achilles* remains unrecorded from the Indian

TABLE 2
FIN-RAY COUNTS OF SPECIMENS OF
Acanthurus leucosternon FROM THE INDIAN OCEAN

LOCALITY	DORSAL SOFT RAYS				ANAL SOFT RAYS			
	28	29	30	31	26	27	28	
Maldive Is.	1		1		1	1		
Seychelle Is.		3	7	1	1	7	3	

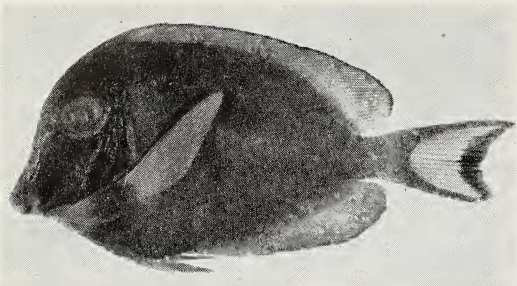


FIG. 4. Juvenile of *Acanthurus leucosternon* Bennett from the Maldiv Islands; standard length 54 mm. Dark area around pectoral fin is shadow. Photo by W. Courtenay.

Ocean, and *A. glaucopareius*, also a near relative, is known in the Indian Ocean only from Cocos-Keeling and Christmas islands.

The juvenile stage of *A. leucosternon* (Fig. 4) is very similar to the adult. The acronurus, unless it is the *Acronurus formosus* of Castelnau (Randall 1956b: 202), has not been described. It may be large like the acronuri of *A. achilles* and *A. glaucopareius*.

Marden (1956: 185) has portrayed *Acanthurus leucosternon* in an underwater color photograph. The body of the fish is bright blue. A broad blackish band curves down from the interorbital region, enclosing eye, and covering most of the operculum. The dorsal fin is bright yellow edged with blue, and the caudal peduncle and region of caudal spine are also yellow. The caudal fin is black with a large crescent of white and a blue margin posteriorly. The anal and pelvic fins are white, and there is a white area on the chest and a white band on the chin.

Dorsal and anal fin-ray counts of *A. lineatus* from the Indian Ocean and the Pacific (Table 3) suggest differentiation of the species in these two oceans. *A. lineatus* is known from the coast of East Africa, but not from the Red Sea where a similar but very distinctive species, *A. sobal*, appears to be endemic.

The dorsal soft rays of three specimens of *Zebrasoma veliferum* from the Maldives number 27-30, and the anal soft rays 22-24. These counts align themselves with those from other Indian Ocean localities which differ significantly from counts of specimens from the Pacific (Randall 1955c: table 1).

Dorsal soft rays of 10 specimens of *Acanthu-*

rus tennenti collected by Morrow in the Seychelles number 22-24 (mostly 23), and the anal soft rays 21-23 (mostly 22).

Smith (1955: 692) listed the acanthurids from the island of Aldabra in the Indian Ocean north of Madagascar and described two of them as new. One, *Acanthurus bicommatatus* (pl. XVIII, C and D in Smith), is a synonym of *A. tennenti*. The second, *A. melanosternon* (pl. XVIII, B), is a valid species, differing from others principally in the nearly black color of the chest which encloses a broad white patch below the middle of the lower preopercular margin, this patch in some specimens continuing as a band midventrally, thus dividing the black area anteroposteriorly. This white band on the chest is suggestive of *A. leucocheilus* Herre from the Philippines, as is the outer pale one-third of an otherwise dark pectoral fin. *A. melanosternon* lacks the bluish-white band at the base of the caudal fin, the black snout with a white band encircling the mouth, and the dark red lines distally in the dorsal and anal fins of *leucocheilus*. Meristic data were given by Smith as follows: D IX, 25-26; A III, 24-25; P 17; gill rakers 21-22. He had numerous specimens, 280-480 mm. in length, taken over a wide area of East African coast as far south as 15° and at various islands in the Indian Ocean.

Also listed by Smith among the species of *Acanthurus* from Aldabra and East Africa is *A. philippinus* Herre (= *A. thompsoni* (Fowler)). This represents the first record of *A. thompsoni* from the Indian Ocean.

Three species of *Ctenochaetus* were recorded

TABLE 3
FIN-RAY COUNTS OF SPECIMENS OF
Acanthurus lineatus FROM INDO-PACIFIC LOCALITIES

LOCALITY	DORSAL SOFT RAYS						ANAL SOFT RAYS			
	25	26	27	28	29	30	25	26	27	28
Maldive Is.	1	1	8	2			1	5	5	1
Seychelle Is.			2	2			1	2	1	
Mauritius			1				1			
Palau Is.			1	4	2				6	1
Mariana Is.			5	9	3		1	10	6	
Samoa Is.			5	2	1		2	5	1	
Society Is.			4	4			3	5		
Marquesas Is.						1				1

by Smith from Aldabra: *C. striatus*, *C. strigosus* (Bennett), and *Ctenochaetus* sp. (the latter species was left undesignated pending the publication of the revision of the genus). He provided information on the latter species in a letter enabling me to identify it as *C. cyanoguttatus* Randall. His specimen is 9 in. in length and was described as having "light blue spots all over in life." This is the first record of *cyanoguttatus* west of the Gilbert Islands, although the blue-spotted *Acanthurus ctenodon* Var.b of Playfair (1866: 57) from Zanzibar is probably also *C. cyanoguttatus*.

After the revision of *Ctenochaetus* was published (Randall, 1955d), a large specimen of *C. cyanoguttatus* from Cocos Island was found at the USNM—probably one of the four specimens of Snodgrass and Heller (1904) originally cataloged at the SNHM. As mentioned in the revision (p. 161), no trace of blue spots could be found on the one Cocos Island specimen seen at Stanford. The National Museum specimen, however, possesses pale bluish spots on the side beneath the pectoral fins which are closely applied to the body. The cover provided by these fins probably prevented the fading of the spots at this location.

Three specimens of *C. cyanoguttatus*, 212, 202, and 120 mm. in standard length, were collected by spearing at Ua Pou in the Marquesas Islands. Numerous small, bright blue spots covered the head, body, and pectoral fins, those posteriorly on the body being smaller. A pale blue band was evident at the base of the dorsal and anal fins. These fins were banded alternately with pale blue and dark yellowish brown. The iris was dark blue. Many individuals underwater displayed whitish lips and a whitish caudal fin. The caudal may also be brown with lengthwise blue streaks. This species was not seen in the Society Islands or Tuamotus but proved to be abundant at the three islands visited in the Marquesas, Ua Pou, Nuku Hiva, and Eiao. On the two occasions when *C. cyanoguttatus* was observed in the Gilbert Islands, it occurred in schools. It was not observed to school in the Marquesas.

C. striatus, probably the most abundant reef fish of its size in the Society Islands, was never seen in the Marquesas, although much effort

was expended to locate it there. The specimen reported by Fowler (1938: 76) as *C. strigosus* from Ua Pou and said to have blue lines on the body was examined at the Academy of Natural Sciences of Philadelphia. It is *C. cyanoguttatus*, and blue spots, not lines, are still evident on the body.

When the two larger specimens of *C. cyanoguttatus* were collected by the author, difficulty was experienced in deciding whether they should be labelled as *C. cyanoguttatus* or *C. magnus* Randall. They were more like *magnus* in general appearance, with greater depth, convex profile, and scales in very irregular rows. There were, however, predominantly four denticulations on the expanded tips of the upper teeth as is seen on teeth of *cyanoguttatus* and not three, a number which was presumed to be diagnostic for *magnus*. Also the bands in the dorsal and anal fins persisted in preservative (these are not visible on the preserved specimens of *magnus*). Leonard P. Schultz kindly loaned the types of *cyanoguttatus* (170.5 mm.) and *magnus* (225 mm.) from the USNM in order that they might be compared with the two large and one small Marquesan specimens. It was noted that some of the upper teeth of the holotype of *magnus* bear four instead of three denticulations. It now seems that the differences between these two forms are principally ones of age, and *magnus* should be referred to the synonymy of *cyanoguttatus*.

Meristic data of the three Marquesan specimens of *cyanoguttatus* are given in Table 4.

Randall (1955b: 189) collected a 35 mm. specimen of *Ctenochaetus* from the Gilbert Islands which was not identified to species. It was brown with a bright yellow caudal peduncle and caudal fin. The specimen is shown in Figure

TABLE 4
COUNTS FROM SPECIMENS OF *Ctenochaetus cyanoguttatus* FROM THE MARQUESAS ISLANDS

STANDARD LENGTH (mm.)	NUMBER OF TEETH		NUMBER OF SOFT RAYS	
	Upper	Lower	Dorsal	Anal
120	41	54	27	24
202	46	65	26	24
212	42	67	27	24

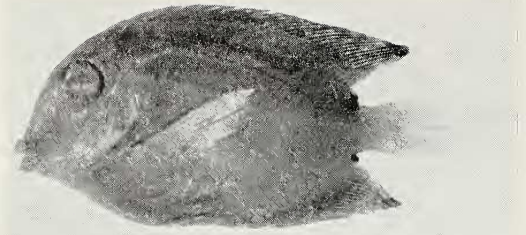


FIG. 5. Juvenile of *Ctenochaetus binotatus* Randall from the Gilbert Islands; standard length 35 mm.

5 of the present paper. As a result of the examination of specimens of *C. binotatus* taken in the Society Islands, it is now apparent that the one from the Gilbert Islands is a juvenile of this species. The upper teeth with seven instead of six denticulations and the bright yellow caudal coloration are juvenile characteristics.

No positive record of the life color of adults was available for the description of *C. binotatus*. The following color notes made from specimens speared in Papetoai Bay, Moorea, are therefore presented. A 130 mm. adult was chestnut brown on the head and body with narrow, blue, lengthwise lines on the body and small blue spots on the head and thorax; the median fins were brown; the caudal, however, was observed to be dull yellow underwater and after the fish was speared the color of the fin alternated from entirely brown to brownish yellow on the upper half and brown on the lower; also evident while the fish was still alive was a temporary suffusion of brownish yellow over the body and dorsal and anal fins; faint diagonal-lengthwise bands of dull orange were visible in the dorsal fin, and the dorsal and anal had a narrow blue-black margin and the diagnostic black spot at rear base of each of these fins; the pectoral membranes were hyaline, the rays yellowish brown; the iris was deep blue. A 31 mm. specimen in a late phase of transformation from the acronurus to the juvenile state was brown with vivid yellow caudal fin, caudal peduncle, and posterior part of dorsal and anal fins (thus emphasizing the black spot at rear base of the latter two fins); blue spots were present anteriorly on the body and blue lengthwise lines posteriorly.

Juveniles are commonly seen on the shore reef of Papetoai Bay at a depth of about 3–6

ft.; adults occur in the bay at a depth of 30–40 ft. at the base of the vertical front of the shore reef. *Acanthurus thompsoni* was observed and collected from the same general habitat, though more over the sand adjacent to the vertical reef front.

Ctenochaetus strigosus is here recorded from the Society Islands and Marquesas for the first time. This species in French Oceania also displays a striking color change from juvenile to adult. The young are entirely bright yellow—the fourth species of surgeonfish known to have a yellow juvenile stage (the others are *Acanthurus pyroferus*, *A. olivaceus*, and *A. coeruleus* Bloch and Schneider; curiously, none of these species appear to be closely related). In the Hawaiian Islands, however, the young of *C. strigosus* are not yellow but are brown like adults. As previously discussed (Randall, 1955d: 159) a notable color difference exists between adults in the Hawaiian Islands and the Philippines and those in the Tuamotus. The caudal fin of Hawaiian and Philippine fish is brown, whereas it is white in specimens from the Tuamotus (and the Societies and Marquesas). Specimens from all of these areas (except the Philippines), when alive have a bright yellow ring around the eye or a rim of yellow adjacent to the posterior edge of the eye. Even the yellow juveniles clearly show a posterior rim of yellow, for the yellow color is brighter adjacent to the eye than on the rest of the head.

In the Society Islands the change from yellow juvenile to dark brown, white-tailed adult coloration takes place at a standard length of about 50 mm. There is considerable variation in size at which this occurs, however. Yellow specimens have been taken which are as large as 54 mm., and brown with white tail have been taken as small as 45 mm. in standard length. At Takaroa, Tuamotus, a specimen was collected which was changing from yellow juvenile to brown adult color at a standard length of 67 mm. A 32 mm. specimen was speared in Moorea at a depth of 20 ft. which was in a late stage of transformation from the acronurus to the juvenile form (there was still a trace of silver over the abdomen, and the scales on the body were not fully formed). The specimen was dull yellow-orange with bright orange caudal fin, a

TABLE 5
FIN-RAY COUNTS OF SPECIMENS OF
Ctenochaetus strigosus FROM THE PACIFIC OCEAN

LOCALITY	DORSAL SOFT RAYS				ANAL SOFT RAYS				
	25	26	27	28	21	22	23	24	25
Hawaiian Is...	4	19	23	1			9	32	6
Philippines and East Indies..	3	6	4				7	6	
Tuamotu Arch.....	4	5	4		1	1	5	5	1
Society Is.....		4	4				1	5	2
Marquesas Is..		1					1		

blue eye, a narrow yellow rim on posterior half of eye, and a narrow black margin on dorsal and anal fins.

Dorsal and anal fin-ray counts (Table 5) of *C. strigosus* are not as indicative of population differentiation as color characters and shape of the caudal fin (Randall, 1955d: 159).

Ctenochaetus hawaiiensis Randall (1955d: 155, 161, fig. 2), formerly known only from the island of Hawaii, was collected by the author in the Tuamotu Archipelago and Society Islands. A 153 mm. specimen was speared at a depth of 120 ft. just north of the entrance to the pass at the atoll of Tikahau, a 194 mm. specimen at a depth of 15 ft. at the edge of a patch reef in the lagoon of Takaroa, and a 163 mm. specimen at a depth of 125 ft. outside the barrier reef at Moorea. In the Tuamotus and Societies this species was occasionally encountered at depths of about 100–130 ft. The only individual seen in these islands in shallow water was the Takaroa specimen. The three specimens collected from French Oceania differed in life color from the species in Hawaii only in their possession of dark blue on the membranes of the pectoral fins. This color was most pronounced in the upper part of the fins. In body proportions and all meristic data they agree with Hawaiian material.

Specimens of *C. binotatus*, *C. strigosus*, and *C. hawaiiensis* from French Oceania have been deposited in the USNM and the SNHM.

Also taken at Takaroa was a perplexing 175 mm. specimen of *Acanthurus* which is very similar to *A. olivaceus*. Instead of a long band

of orange surrounded with deep blue on the shoulder area, the orange in this specimen was restricted to a small elongate patch extending posteriorly from the upper end of the gill opening for a distance equal to one eye diameter (Fig. 6); the dark blue band, the diameter of an eye in width, extended as a solid area as far as the tip of the pectoral fin (when this fin was applied to the body). When the specimen was first seen, the caudal fin was cream except for dark edges and a semicircular black area in the median posterior part of the fin. After being speared, the pale portion of the fin darkened to light yellowish brown. The caudal fin of *A. olivaceus* is normally dark brown with a semicircular area of white (except for narrow black posterior margin) in the same location as the black area of the specimen in question. In other respects the color was like *olivaceus*. There was a deep brownish-red band at the extreme base of the dorsal and anal fins; the anal was narrowly edged with blue; the outer third of the pectoral fins was hyaline with a tinge of yellow. The specimen was observed swimming with several *A. olivaceus* before it was speared. Later four specimens of *olivaceus* were speared in the same area to provide comparison. No differences other than color could be ascertained. The fin-ray and gill-raker counts of the specimen (D IX, 24; A III, 23, P 17; gill rakers 26) are within the range of the four

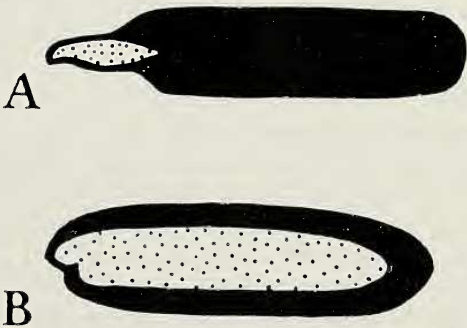


FIG. 6. A, Color mark which extends posteriorly from upper end of gill opening of a 178 mm. variant of *Acanthurus olivaceus* Bloch and Schneider, taken at Takaroa, Tuamotus. The same mark occurred on all of the *A. olivaceus* specimens seen in the Marquesas. B, Usual color mark on shoulder of *A. olivaceus*. The stippled region represents bright orange, the black area dark blue.

olivaceus (D IX, 24-25; A III, 23-24; P 17; gill rakers 25-28). Two of the four *olivaceus* displayed a restriction in width and intensity of color of the posterior part of the orange shoulder band. None, however, showed a darkening of the white posterior area of the otherwise dark caudal fin.

At the time it was collected, the specimen was regarded as an aberrant color form of *olivaceus*. Later at Ua Pou and Nuku Hiva in the Marquesas, all of the *olivaceus* which were seen were colored like this one Takaroa specimen. Therefore it now seems likely that *A. olivaceus* is subspecifically different in the Marquesas and that occasional individuals drift as larvae to the northern Tuamotus where they may intergrade with the common *olivaceus* form there. Because of a limited supply of formalin, only a single specimen was brought back from the Marquesas. It was speared in Anaho Bay, Nuku Hiva, on July 16, 1957. It is 196 mm. in standard length. The shoulder mark is 60 mm. in length, and the orange part of it 17 mm. The caudal fin was pale yellowish with a black crescent mid-posteriorly.

The Takaroa specimen was deposited in the USNM and the Nuku Hiva one at the SNHM. No nomenclatorial designation of the Marquesan subspecies is offered at this time. Additional specimens should be procured from both the Marquesas and Tuamotus.

A specimen of *Acanthurus olivaceus* in the intermediate stage between yellow juvenile and brown adult coloration was collected in the pass of Takaroa. It is 134 mm. in standard length.

A year's collecting of fishes in the Society Islands and Tuamotus, resulting in the taking of over 350 species of reef fishes, failed to yield any specimens of the yellow *Zebrasoma flavescens* (Bennett), although the brown *Z. scopas* (Cuvier) proved to be common (additional fin-ray counts of the latter continue to be predominantly D IV, 24; A III, 20). When a relatively large individual of the species *Acanthurus pyroferus* still in the yellow color phase was first sighted underwater in Tahiti by the author, it was mistaken for *Z. flavescens*. The error was not perceived until the specimen was speared and regarded closely. *Z. flavescens* is recorded

to date from the Hawaiian Islands, Johnston Island, Wake Island, northern Marshall Islands, and Mariana Islands. Eibl-Eibesfeldt (1955: 217), in a paper concerning fish behavior, mentioned yellow *Z. flavescens* from Cocos Island off Costa Rica. This record was based on underwater observation and should be substantiated with the collection of specimens.

A specimen of *Zebrasoma scopas*, 25 mm. in standard length, which was transforming from the late postlarval or acronurus stage to the juvenile form, was collected in Papetoai Bay, Moorea, at a depth of 30 ft. on September 18, 1956. It was dark brown, shading to purplish brown anteriorly, with vertical pale lines; the chest was silvery and mottled with brown; the ends of the median fins were narrowly hyaline. Another, 26 mm. in standard length, was taken in the bay March 21, 1957.

Zebrasoma rostratum (Günther) has been recorded previously only from the Society Islands and the Tuamotus. This distinctive long-snouted surgeonfish was collected by the author at Takaroa and Takapoto in the Tuamotus, where it is common on the outer reef. In spite of extensive collecting in the Society Islands, the type locality, it was not taken, nor was it observed. The range of the species is here extended to include the Marquesas (one specimen taken at Anaho Bay, Nuku Hiva), Caroline Atoll (one specimen taken off the lee reef), and Palmyra, Line Islands (two specimens collected by R. R. Rofen).

A large adult *Naso rigoletto* Smith (1951: 1126-1132, fig. 1), the most characteristic feature of which is a marked depression in the contour of the back at the base of the spinous portion of the dorsal fin followed by a hump, was sighted by the author in the lagoon of Moorea, Society Islands, at a depth of 90 ft., but the fish was not taken. Subsequently two large specimens were purchased from the market in Papeete, Tahiti. One was shipped to the SNHM, and the other (Fig. 7) to the USNM. This is the first record of the species from the Pacific. It was previously known only from East Africa. The National Museum specimen is a 565 mm. female lacking a horn on the fore-

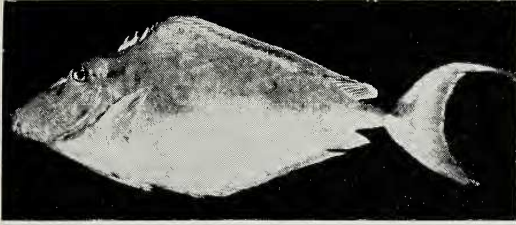


FIG. 7. *Naso rigoletto* Smith from Tahiti; standard length 565 mm. Reproduced from a 35 mm. Kodachrome transparency.

head (according to Smith, only the males of this species possess a long rostral prominence). This fish was gray on the dorsal half of the body and light gray ventrally. There were about five small blue spots anteriorly on the body above the pectoral fin and two such spots posteriorly on the head. The caudal spines were not colored. Fin-ray counts are as follows: D V, 30; A II, 29; P 17.

N. rigoletto was sighted underwater at Eiao, Marquesas, as was *N. lituratus* (Bloch and Schneider), but was not taken.

The surgeonfishes previously known from the Marquesas Islands include *Ctenochaetus cyano-guttatus*, *Acanthurus lineatus*, *A. triostegus*, and *A. glaucopareius*; all of these are common. The acanthurids which represent new additions to the Marquesan fauna are *A. pyroferus*, *A. olivaceus*, *Ctenochaetus strigosus*, *Zebrasoma rostratum*, *A. achilles*, *A. guttatus* Bloch and Schneider, *A. nigroris* Cuvier and Valenciennes, *A. xanthopterus* Cuvier and Valenciennes (a 474 mm. specimen; only the head preserved), *A. bleekeri* Günther, and *Naso unicornis* (Forskål). The specimen of *Acanthurus bleekeri* is 280 mm. in standard length. It was one of a school of about 30 fish at Eiao which varied in hue from pale bluish to dark brown. The broad yellow band through the eye was conspicuous regardless of ground color.

The specimen of *Naso unicornis* measured 448 mm. in standard length; it possessed a horn which extended directly forward from the eye. The lower edge of the horn measured 52 mm. from the head. Counts of the specimen were as follows: D VI, 30; A III, 29; P 18. The color in life was gray on the back shading to yellow ventrally, with a patch of blue blotches

in the region of the pectoral fin; the dorsal and anal fins were alternately striped with diagonal bands of orange and blue; the caudal fin was gray, becoming yellowish outwardly. Only the caudal region and snout were preserved.

Most of the acanthurids from the Marquesas Islands have been deposited in the SNHM.

Although only 12 days were spent in collecting and observing fishes in the Marquesas, it seems likely that certain surgeonfishes such as *Ctenochaetus striatus*, *Acanthurus nigrofuscus*, and *A. gabbm*, common throughout the South Seas, are absent in this island group. Little observation is needed to notice that the Marquesas have an impoverished fish fauna. This is more evident for many other families of fishes, such as the Labridae and the Chaetodontidae, than it is for the acanthurids. The explanation for the scant fauna probably lies both in the eastern position of the Marquesas in the Indo-Pacific in a region of westward-moving current and in the paucity of coral reefs.

SUMMARY

1. *Acanthurus chronixis* is described as new from Kapingamarangi Atoll, Caroline Islands. The description is based on a single 211 mm. specimen. Two juveniles from Ifaluk in the Carolines, probably belonging to this species, are described in detail. Due to slight meristic differences from the holotype, these small specimens are not designated as paratypes.

A. chronixis is one of three known species of *Acanthurus* with eight dorsal spines. It appears to be closely related to *A. pyroferus*, sharing with it the dorsal-spine count, a somewhat produced snout, and a spherical, thick-walled stomach. It differs from *A. pyroferus* primarily in color pattern.

2. The juvenile stage of *Acanthurus pyroferus* is bright yellow in life with blue and orange markings and a rounded caudal fin. It closely resembles the angelfish *Centropyge flavissimus*, thus suggesting mimicry.

3. The population of *Acanthurus pyroferus* in the Society Islands appears differentiated from populations in the Marshall Islands and Philippines on the basis of a higher number of soft rays in the dorsal and anal fins.

4. Three specimens of the hybrid surgeonfish *Acanthurus achilles* \times *Acanthurus glaucopareius*, previously known only from Hull Island in the Phoenix group, were collected in the Tuamotu Archipelago. The life color of the hybrids was noted to be intermediate to the parent species.

5. *Acanthurus nubilus*, heretofore known only from Celebes, was collected in Moorea, Society Islands, where it is not uncommon outside the barrier reef at depths of about 100 ft. The life colors are given.

6. The acanthurids from a collection of fishes in the Indian Ocean by J. Morrow are reported on briefly. Fin-ray counts are given for *Acanthurus leucosternon*, *A. lineatus*, *A. tennenti*, and *Zebrasoma veliferum*.

7. *Acanthurus bicommatatus* Smith (1955: 694) is a synonym of *A. tennenti*. *A. melanosternon* Smith (1955: 693) from East Africa and islands in the Indian Ocean is a valid species.

8. *Ctenochaetus* sp. Smith (1955: 693) from Aldabra, Indian Ocean appears to be *C. cyanoguttatus*.

9. *Ctenochaetus magnus* Randall (1955d: 155, 162) is referred to the synonymy of *C. cyanoguttatus*.

10. The specimen from Ua Pou, Marquesas, reported by Fowler (1938) as *Ctenochaetus strigosus* is *C. cyanoguttatus*. This species is common in the Marquesas, but *C. striatus*, usually abundant in the tropical Pacific, was not observed in this island group.

11. The 35 mm. *Ctenochaetus* sp. Randall (1955b: 189; 1955d: 164) from the Gilbert Islands is a juvenile *C. binotatus*. This species is recorded from the Society Islands, and the juvenile and adult life colors are given.

12. *Ctenochaetus strigosus* is recorded from the Society Islands. The young of this species in this island group and the Tuamotu (but not in the Hawaiian Islands) are bright yellow in life.

13. *Ctenochaetus hawaiiensis* is recorded from the Tuamotu Archipelago.

14. *Acanthurus olivaceus* is subspecifically distinct in the Marquesas Islands. Evidence of intergradation with the usual *olivaceus* form in the northern Tuamotu is presented.

15. The brown *Zebrasoma scopas* is common in the Societies and Tuamotu, but extensive collecting and underwater observation failed to reveal any of the yellow *Z. flavescens* in these islands.

16. The range of *Zebrasoma rostratum* is extended to include the Marquesas Islands, Caroline Atoll (10° S., 150° W.), and Palmyra in the Line Islands.

17. Two specimens of *Naso rigoletto*, known previously only from East Africa, were obtained in Tahiti, Society Islands.

18. The following surgeonfishes are here recorded from the Marquesas for the first time: *Acanthurus pyroferus*, *A. olivaceus*, *A. achilles*, *A. guttatus*, *A. nigroris*, *A. xanthopterus*, *A. bleekeri*, *Ctenochaetus strigosus*, and *Naso unicornis*.

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